Clamping force block
TANDEM KRE3, KRE3-LH & KSE3, KSE3-LH
Software manual

Hand in hand for tomorrow

Imprint

Technical changes:
We reserve the right to make alterations for the purpose of technical improvement.

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Dear Customer,

Thank you for trusting our products and our family-owned company, the leading technology supplier of robots and production machines.

Our team is always available to answer any questions on this product and other solutions. Ask us questions and challenge us. We will find a solution!

Best regards,

Your SCHUNK team

Customer Management

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Please read the software manual in full and keep it close to the product.

Table of Contents

1 General

1.1 Validity

This version of the software manual for the KRE3 (-LH) and the KSE3 (-LH) describes the functions for the firmware versions with the main version number 1.1.1. The firmware version can be read out. Information on the corresponding parameter can be found in the chapter ▶ 4.1 [🗋 15].

1.2 Applicable documents

- General Terms and Conditions
- Operating manual of the products used
- IO-Link Device Description (IODD)

The documents can be downloaded from **www.schunk.com**.

1.3 IO-Link Basics

Fieldbus-independent interface

IO-Link is a point-to-point interface for connecting a SCHUNK product (IO-Link device) to a control system (IO-Link master). Via this interface it is possible to transfer parameters, process data and diagnostic data. Parameter data are transfered to the IO-Link device from the master (actuator or sensors). In the opposite direction, the master receives cyclical process data and, if required, service and diagnostic data.

Further information on IO-Link can be found at **www.io-link.com**.

1.4 Data exchange

Cyclical data exchange

To exchange cyclic process data between an IO-Link device and a controller, the IO-Link data is transferred from the IO-Link master to the previously set address ranges. The user program of the controller accesses the process values via these addresses and processes them. Conversely, the cyclic data exchange is performed from the controller to the IO-Link device.

Acyclical data exchange

The exchange of acyclic data, such as parameters or events, takes place over a specified index and sub-index range. Using the index and sub-index range, targeted access of the device data is possible (e.g. for reparameterization of the device or master during ongoing operation).

1.5 Data types

The data types mentioned in this version of the software manual are designated according to the "IO-Link Interface and System Specification", Annex F, Version 1.1.9, which is available at **www.io-link.com**. The corresponding designation according to IEC 61131-3 (PLC standard) can be found in the following table:

Description	IO-Link standard	PLC standard IEC 61131-3	Bit length
Logical value	BooleanT	BOOL	1 bit
Integer	IntegerT8	SINT	8 bit
	IntegerT16	INT	16 bit
	IntegerT32	DINT	32 bit
	IntegerT64	LINT	64 bit
Natural number	UIntegerT8	USINT	8 bit
	UIntegerT16	UINT	16 bit
	UIntegerT32	UDINT	32 bit
	UIntegerT64	ULINT	64 bit
Floating-point numbers	Float32T	REAL	32 bit
	Float64T	LREAL	64 bit
Characters	StringT (x)	STRING	x bit

⚠ WARNING

Changes to parameters outside the permitted ranges and manipulation of non-visible and therefore protected parameters can cause damage to the clamping force block or misinterpretation of states and thus lead to an unwanted hazard.

2 Incoming process data (status word)

To determine the current device status and clamping status, as well as the current device temperature and sensor raw values, the following incoming cyclical data from the clamping force block (device) is made available:

Byte	Bit *	Bit offset	Sub index	Data type	[Values]: Description
0	7	191	1	BooleanT	[true]: Ready for operation; [false]: otherwise
	6	190	2	BooleanT	[true]: Referenced; [false]: otherwise
	5	189			
	4	188			
	3	187	5	BooleanT	[true]: Blocked; [false]: otherwise
	2	186	6	BooleanT	[true]: Actuator active; [false]: otherwise
	1	185	7	BooleanT	[true]: Clamped; [false]: otherwise
	0	184	8	BooleanT	[true]: Loading position reached; [false]: otherwise
1	7	183			
	6	182			
	5	181			
	4	180			
	3	179			
	2	178	14	BooleanT	[true]: Info; [false]: otherwise
	1	177	15	BooleanT	[true]: Warning; [false]: otherwise
	0	176	16	BooleanT	[true]: Error; [false]: otherwise
2–3	–	160	17	UInteger T16	Eventcode
4–7	–	128	18	Float32T	Position (mm)
8–11	–	96	19	Float32T	Speed of rotation (rpm)
12–15	–	64	20	Float32T	Motor current (mA)
16–19	–	32	21	Float32T	Current limit (mA)
20–23	–	0	22	Float32T	Temperature (°C)

* Bit 7 has the function of the **M**ost **S**ignificant **B**it (**MSB**) and bit 0 that of the **L**east **S**ignificant **B**it (**LSB**).

Further information is provided via the acyclic device data ▶ 4 [🗋 15].

2.1 Status – Byte 0

The current status of the device and the status of theclamping force block is displayed:

Bit	Bit offset	Sub index	Data type	Values: Description
7	191	1	BooleanT	[true]: Ready for operation; [false]: otherwise
6	190	2	BooleanT	[true]: Referenced; [false]: otherwise
3	187	5	BooleanT	[true]: Blocked; [false]: otherwise
2	186	6	BooleanT	[true]: Actuator active; [false]: otherwise
1	185	7	BooleanT	[true]: Clamped; [false]: otherwise
0	184	8	BooleanT	[true]: Loading position reached; [false]: otherwise

The internal sensor system of the clamping force block detects the jaw position and the clamping force. The clamping state of the clamping force block is determined from the command specifications of the outgoing control word, see ▶ 3.2 [🗋 14], and output via the corresponding status bits.

The operational status of the device is indicated by the Boolean value of bit 7 "Ready for operation". The prerequisite is that the two 24 V supply voltages L+ and 2L+ are present.

Bit 6 "Referenced" indicates the successful execution of a reference run, ▶ 3.1.5 [🗋 13].

The Boolean value of bit 3 "Blocked" indicates a blocked state of the clamping device. If the Boolean value is [true], the "Clamping" command (see ▶ 3.1.3 [🗋 11]) cannot be executed. The commands "Release to loading position" and "Referencing" are still possible.

Note: The internal logic recognizes a blocked state, for example, if the "Release to loading position" command (see ▶ 3.1.4 [🗋 12]) is executed after an incorrectly set loading position. With O.D. clamping and an inserted workpiece, a value smaller than the clamping position is an incorrectly set loading position. The Boolean value of bit 2 "Actuator active" indicates the status of the actuator.

The clamping status of the clamping force block is indicated by the Boolean value of bit 1 "Clamped". The prerequisites for the value [true] are:

- Previously triggered "Clamping" command (▶ 3.1.3 [🗋 11])
- Reaching the specified value for the clamping force (%), (▶ 3.2.1 [🗋 14])

- Minimum clamping stroke (mm) (index 331, acyclic parameters, ▸ 4.2 [🗋 16]) is smaller than the difference between the start value when the command is triggered and the actual value of the jaw position after the clamping process.

The displayed status remains stored after a power failure until a new drive command is set.

The Boolean value of bit 0 "Loading position reached" indicates that the value of the loading position (mm) (▸ 3.2.2 [🗋 14]) has been successfully reached after a positioning movement previously started with the command "Release to loading position" (▸ 3.1.4 [🗋 12]). The displayed status “Loading position reached” is not stored in case of a power failure and may require the drive command “Release to loading position” (▸ 3.1.4 [🗋 12]) to be set again.

A successfully referenced and operational clamping device (bit 7 and bit 6 each [true]) is a prerequisite for executing clamping and unclamping movements. An additional prerequisite for the execution of clamping movements is a non-blocked state (bit 3 [false]).

2.2 Exception – Byte 1

The occurrence of exception events in the form ofinformation, warnings and errors are displayed:

Bit	Bit offset	Sub index	Data type	Values: Description
2	178	14	BooleanT	[true]: Info; [false]: otherwise
1	177	15	BooleanT	[true]: Warning; [false]: otherwise
0	176	16	BooleanT	[true]: Error; [false]: otherwise

Warnings can be reset with the command " Acknowledge warning", ▸ 3.1.6 [🗋 13]. Errors can be deleted by rebooting the device. If warnings are not reset, this can prevent commands from being executed.

2.3 Event code – Byte 2-3

Warnings are indicated by a specific code in combination with the occurrence of a warning (byte 1 bit 1 "Warning" [true]):

Bit offset	Sub index	Data type	Values: Description
160	17	UIntegerT16	[0x0001]: Not ready for operation [0x0002]: Clamping device busy [0x0003]: Clamping device not referenced [0x0004]: Clamping device already clamped [0x0005]: Command not possible in current state [0x0006]: Invalid target value

The event code is also reset with the command "Acknowledge warning" (▸ 3.1.6 [🗋 13]). Error and warning messages from the motor control unit are displayed directly in the event code.

2.4 Position – Byte 4–7

The current jaw position is displayed in units of (mm). The jaw position indicates the distance of a base jaw from the position at zero position (closed), see Fig. 1 and 2.

Bit offset	Sub index	Data type	Values: Description
128	18	Float32T	[0... Referenced maximum stroke]: Position (mm)

2.5 Rotational speed – Byte 8–11

The current engine speed measured by the engine control unit is displayed in units of (rpm).

Bit offset	Sub index	Data type	Values: Description
96	19	Float32T	[–]: Speed of rotation (rpm)

2.6 Motor current – Byte 12–15

The current motor current measured by the motor control unit is displayed in units of (mA).

Bit offset	Sub index	Data type	Values: Description
64	20	Float32T	[–]: Motor current (mA)

2.7 Current limit – Byte 16–19

The current limit currently set by the logic is displayed in units of (mA).

Bit offset	Sub index	Data type	Values: Description
32	21	Float32T	[–]: Current limit (mA)

2.8 Temperature – Byte 20–23

The temperature currently measured by the motor control unit is displayed in units of (°C).

Bit offset	Sub index	Data type	Values: Description
0	22	Float32T	[–]: Temperature (°C)

NOTICE

Bit values of unassigned bits (N.N.) are always set as 0: [false].

3 Outgoing process data (control word)

The following cyclical process data from the master is received by the clamping force block (device) and processed accordingly to execute commands and to specify commands for set values for the clamping force and loading position:

Byte	Bit *	Bit offset	Sub index	Data type	[Values]: Description
0	7	79	1	BooleanT	[true]: I.D. clamping; [false]: otherwise
	6	78	2	BooleanT	[true]: Reduced velocity (clamping) at 100 % clamping force; [false]: otherwise
	5	77			
	4	76			
	3	75	5	BooleanT	[true]: Clamping; [false]: otherwise
	2	74	6	BooleanT	[true]: Release to loading position; [false]: otherwise
	1	73	7	BooleanT	[true]: Referencing; [false]: otherwise
	0	72	8	BooleanT	[true]: Acknowledge warning; [false]: otherwise
1	–	64			Reserved
2–5	–	32	9	Float32T	Clamping force (%)
6–9	–	0	10	Float32T	Loading position (mm)

* Bit 7 has the function of the **M**ost **S**ignificant **B**it (**MSB**) and bit 0 that of the **L**east **S**ignificant **B**it (**LSB**).

3.1 Commands – Byte 0

Commands are executed by setting the corresponding bit to the value 1: [true]. If more than one command is set at the same time (exception: I.D. clamping and reduced velocity), none of the set commands are executed, a command that is currently being executed is interrupted, the motor is stopped and a warning is also issued via the status word.

NOTICE

Unassigned bits must always be set as 0: [false].

3.1.1 Bit 7: I.D. clamping

The I.D. clamping option defines the clamping direction of the"Clamping" command, i.e. it is not a move command itself. With O.D. clamping (value 0: [false]), the base jaws move from the outside to the inside, the workpiece is clamped from the outside. With I.D. clamping (value 1: [true]), the base jaws move from the inside to the outside, the workpiece is clamped from the inside.

Control word Byte 0 – I.D. clamping

Bit	Bit offset	Sub index	Data type	Do not execute	Execute
7	79	1	BooleanT	0: [false]	1: [true]

3.1.2 Bit 6: Reduced velocity (clamping) at 100 % clamping force

Depending on the size and stroke variant of the clamping force block, the entire clamping force range of 30 % – 100 % of the nominal clamping force cannot be achieved with the maximum motor speed.

Therefore, the actuator is factory-set to two clamping velocities:

– (a) Nominal speed for: 100% of nominal clamping force

– (b) Reduced speed / rotational speed for: 30%–100% of nominal clamping force

The option "Reduced velocity (clamping) at 100% clamping force" is not a separate drive command.

If bit 6 is set to the value 0: [false], a clamping movement (▶ 3.1.3 [🗋 11]) is performed depending on the set value of the clamping force (%) command (see 3.2.1; page 14):

- Clamping force = 100%: Setting (a) at nominal speed
- 30% ≤ clamping force < 100%: Setting (b) at reduced speed

If bit 6 is set to the value 1: [true], a clamping movement is always performed in setting (b) with reduced speed/rotational speed, regardless of the value set for the clamping force (%) command.

Control word Byte 0 – Reduced velocity (clamping) at 100 % clamping force

Bit	Bit offset	Sub index	Data type	Do not execute	Execute
6	78	2	BooleanT	0: [false]	1: [true]

3.1.3 Bit 3: Clamping

A clamping movement is performed regardless of the current jaw position. The jaws move until the set target value for the clamping force in units of (%) of the nominal clamping force is reached, ▶ 3.2.1 [🗋 14]. With O.D. clamping (bit 7: internal clamping value 0: [false]), the jaws close in the direction of position 0 mm, they move from the outside to the inside. During I.D. clamping (bit 7: ID clamping value 1: [true]), the jaws open in the direction of the maximum position, which corresponds to the maximum clamping stroke per jaw referenced during the last reference run. The jaws move from the inside to the outside.

The clamping force block starts the clamping movement as soon as the value of bit 3: Clamping changes from 0: [false] to 1: [true] and the following preconditions are met:

- No further command bits set (except bit 7: I.D. clamping)
- Clamping device is ready for operation and referenced, i.e. status bit 7 "Ready for operation" and status bit 6 "Referenced" both show the value 1: [true].
- Clamping device is not blocked, i.e. status bit 3 "Blocked" shows the value 0: [false]
- No warning and no error pending

The actuator stops as soon as the value of bit 3 "Clamping" changes from 1: [true] to 0: [false], or the current position moves into the safety distance of the stroke end positions (Fig. 4, ▸ 3.1.4 [🗋 12]).

Attention: A minimum stroke of ≥ 0.2 mm must be maintained when performing a clamping movement. If a clamping movement starts at a position with a distance of less than 0.2 mm to the clamping point, reliable clamping force regulation cannot be guaranteed. This can lead to damage to the workpiece or the clamping force block. This also applies to movements with the "Release to loading position" command (see ▸ 3.1.4 [🗋 12]) in the direction of the clamping point.

Control word Byte 0 – Clamping command

Bit	Bit offset	Sub index	Data type	Do not execute	Execute
3	75	5	BooleanT	0: [false]	1: [true]

3.1.4 Bit 2: Release to loading position

The set nominal value for the jaw position set via the control word " Loading position (mm)", see ▸ 3.2.2 [🗋 14], is approached (positioning run). Only values that are smaller than the value "Referenced maximum stroke" reduced by the value "Safety distance stroke end position (mm)", see ▸ 4.2 [🗋 16], index 330, and larger than the value "Safety distance stroke end position (mm)" can be approached (green area in figure). Otherwise the drive will not be executed.

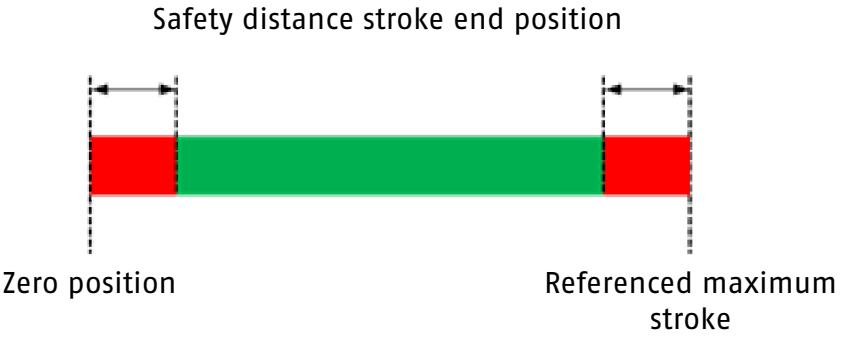

Fig. 4

The clamping force block starts the positioning movement as soon as the value of bit 2: Release to loading position changes from 0: [false] to 1: [true] and the following preconditions are met:

- No further command bits set (except bit 7: I.D. clamping and bit 6: reduced velocity)
- Clamping device is ready for operation and referenced, i.e. status bit 7 "Ready for operation" and status bit 6 "Referenced" both show the value 1: [true].
- No warning and no error pending

The actuator stops as soon as the value of bit 2 changes from 1: [true] to 0: [false].

Control word Byte 0 – Release to loading position command

Bit	Bit offset	Sub index	Data type	Do not execute	Execute
2	74	6	BooleanT	0: [false]	1: [true]

3.1.5 Bit 1: Referencing

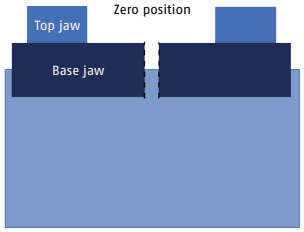

Fig. 1: Zero position

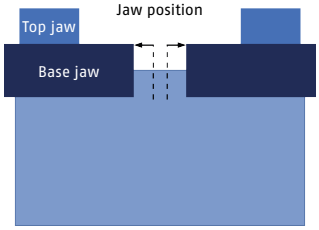

Fig. 2: Jaw position

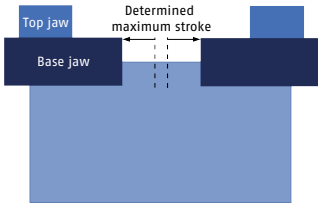

Fig. 3: Referenced maximum stroke

During referencing, the clamping device moves to the mechanical end stops. The zero position (smallest mechanical distance between the base jaws in zero position, (Fig. 1)) and the value for "Referenced maximum stroke (mm)" (corresponds to the maximum jaw stroke, (Fig. 3)) are defined and adopted as the new acyclical parameter for index 332, see ▶ 4.2 [🗋 16].

Specially defined speeds and forces are specified for the reference run. Referencing must be carried out if status bit 6 "Referenced" displays the value 0: [false] in the operational state, e.g. if the 24 V voltage supply was interrupted during a movement.

Before a reference run, make sure that all workpieces have been removed and that the jaws can move freely.

The clamping force block starts the reference run as soon as the value of bit 1 "Referencing" changes from 0: [false] to 1: [true] and the following preconditions are met:

- No further command bits set
- Clamping device is ready for operation, i.e. status bit 7 shows the value 1: [true].
- No warning and no error pending

The actuator stops as soon as the value of bit 1: Referencing changes from 1: [true] to 0: [false].

After a successful reference run, status bit 6 "Referenced" shows the value 1: [true], ▶ 2.1 [🗋 7].

Control word Byte 0 – Referencing command

Bit	Bit offset	Sub index	Data type	Do not execute	Execute
1	73	7	BooleanT	0: [false]	1: [true]

3.1.6 Bit 0: Acknowledge warning

Warnings can be reset with this command. If there are no warning-triggering conditions, the exception bit 6 "Warning" then changes to the value 0: [false].

Control word Byte 0 – Acknowledge warning

Bit	Bit offset	Sub index	Data type	Do not execute	Execute
0	72	8	BooleanT	0: [false]	1: [true]

3.2 Command specifications - Byte 2-9

3.2.1 Byte 2-5: Clamping force (%)

The specification for the clamping force to be applied when performing a clamping run (▶ 3.1.3 [🗋 11]) must be specified in units of (%) of the nominal clamping force of the respective size variant of the clamping force block.

Attention:
Values in the range from 30% to 100% are permitted (▶ 3.1.2 [🗋 11]). Clamping movements are not performed for values that deviate from this range, and a corresponding warning message is displayed.

Control word Byte 2-5 - Clamping force (%)

Bit offset	Sub index	Data type	Values: Description
32	9	Float32T	30...100: Specification for the clamping force (%)

3.2.2 Byte 6-9: Loading position (mm)

The nominal value specification for the jaw position to be approached when executing the "Move to loading position" move command must be specified in units of (mm). The jaw position is the distance of a base jaw from the zero position (closed), (Fig. 1 & 2). If the nominal value specification is outside the green range described in ▶ 3.1.4 [🗋 12], the above movement command is not executed and a warning is issued. The nominal value also serves as a specification for the " Loading position reached" status detection.

Control word Byte 6-9 - Loading position (mm)

Bit offset	Sub index	Data type	Values: Description
0	10	Float32T	Nominal value specification for the insertion position in (mm)

4 Acyclical data

Identification data, monitoring values, parameters and diagnostic information including events and error messages are transmitted acyclically from the IO-Link master on request and can be changed depending on the applicable access rights.

4.1 Identification data

The following acyclic data is provided for identification:

Index	Name	Data type	Access rights *	[Values] description
16	Vendor name	StringT (64)	ro	[SCHUNK SE & Co. KG]
17	Vendor text	StringT (64)	ro	[schunk.com]
18	Product name	StringT (64)	ro	{Produkt name e.g.: TANDEM KSE-3 LH 160 IOL}
19	Product ID	StringT (64)	ro	{material number}
20	Product text	StringT (64)	ro	[Electromechanical clamping force block]
21	Serial number	StringT (16)	ro	{Alphanumeric serial number}
22	Hardware revison	StringT (64)	ro	[HW-V{Version}] (Electronics)
23	Firmware revision	StringT (64)	ro	[HW-V{Version}]
24	Application-specific tag	StringT (32)	rw	{empty textfield for usage specific identification}
25	Function tag	StringT (32)	rw	
26	Location tag	StringT (32)	rw	

* ro (read only), rw (read and write), wo (write only)

4.2 Parameters

The following acyclic data is provided for setting generally accessible parameters:

Index	Name	Data type	Access rights *	[Values] description
330	Safety distance stroke end position (mm)	Float32T	rw	Distance to the end positions that cannot be exceeded during clamping and unclamping.
331	Minimum stroke Clamping (mm)	Float32T	rw	Distance that must be covered for the "Clamped" status to be detected.
332	Referenced maximum stroke (mm)	Float32T	ro	Referenced maximum stroke during the last successful referencing.
333	Expected maximum stroke for plausibility check (mm)	Float32T	rw	Maximum stroke expected for plausibility check during reference run.

* ro (read only), rw (read and write), wo (write only)

There are additional parameters not shown here, including those for setting the motor control. It is not necessary to change these settings for normal operation.

⚠ WARNING

Changes to parameters outside the permitted ranges and manipulation of non-visible and therefore protected parameters can cause damage to the clamping force block or misinterpretation of states and thus lead to an unwanted hazard.

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